RESEARCH ON EFFECTIVENESS OF TECHNOLOGY TRANSFER IN TECHNOLOGY ALLIANCES: EVIDENCE FROM TURKISH SMES

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Abstract

Many SMEs homed in newly industrialized countries are successful international players despite limited technological infrastructure and R&D resources. This study bridges a gap in the extant literature by examining the relationships between characteristics of partnership relationships, knowledge sharing and the effectiveness of technology transfer in partnerships between SMEs in developing countries and firms from developed countries. By studying data from Turkish SMEs and using partial least squares structural equation modelling, we find that explicit knowledge sharing forms the basis of technology transfer. Moreover, our findings demonstrate that explicit knowledge sharing is strongly contingent upon formalised technical support while trust and technical support seemed to be important antecedents of tacit knowledge sharing.

Keywords: Technology transfer, knowledge sharing, alliances, developing countries.

Introduction

It is widely recognised that knowledge ranks high in the hierarchy of strategically relevant resources in firms (e.g. Lee, 2005). Several theoretical perspectives can be distinguished in the recent literature on the role of firm-specific

knowledge in competitive strategy. For example, the resource-based view (RBV) of the firm describes the business enterprise as a bundle of sticky and difficult-to-imitate resources (Barney et al. 2011). A central tenet of this view is that easily transferable resources or technologies cannot form the basis of sustainable competitive advantage (Barney, 1991). Yet, many manufacturing firms homed in newly industrialized countries have become successful international competitors largely through transferring knowledge and technologies in alliances with foreign partners from developed countries (Lin, 2003, Asakawa and Westney, 2013). Knowledge sharing plays a significant role in facilitating the internationalization of SMEs, particularly by promoting technology development (Zaied et al., 2015; Costa et al., 2016). Hence, inter-organizational knowledge and technology sharing in partnership relationships have become focal themes in Knowledge Management (KM) studies (Dahl and Pedersen, 2004).

Scholars have argued that alliances offer a platform for knowledge sharing since they provide firms with access to the skills and competencies of their partners and facilitate capability flows between the partners (e.g., Kogut, 1988; Lee et al., 2012). Recent research stresses the importance of knowledge-sharing mechanisms in alliances (e.g. Estrada et al., 2016; Khalid and Bhatti, 2015; Khan et al., 2015; Ritala et al., 2015) and asserts that knowledge sharing in partnerships is founded on a process of reciprocal communication (e.g. Foss and Pedersen, 2002; Minbaeva et al., 2003; Minbaeva, 2007; Pak and Park, 2004;). The type of knowledge - tacit or explicit - and socio-technological factors, including trust, openness of knowledge-sharing channels and technical support, have been recognized as antecedents of

knowledge sharing (e.g., Dahl and Pedersen, 2004; Frank et al., 2015, Gorschek et al., 2006; Levin and Cross, 2004; Norman, 2002; Singh, 2007).

However, knowledge sharing in partnerships involves tensions due to the necessity to protect valuable knowledge from opportunistic behaviour, which can destroy it as a source of sustainable competitive advantage (Lin, 2003; Lee et al., 2012). RBV posits that possessing and exploiting valuable and rare resources will contribute to creating a competitive advantage for the firm (Barney, 1991; Fredericks, 2005). Further, if these resources are also inimitable and non-substitutable, the firm will attain sustainable competitive edge (Barney, 1991; Eisenhardt and Martin, 2000; Fredericks, 2005). Thus, the imitability of valuable knowledge is crucial to the sustainability of competitive advantage (Foss and Pedersen, 2002; Lee et al., 2012).

KM theory suggests that tacit knowledge is not easily replicable and transferable (Nonaka and Takeuchi, 1995; Kessler et al., 2000), which makes its effective sharing possible only when close relationships are established between the partners to secure willingness, time and sincere efforts (Minbaeva, 2007). Hence, the level of tacit knowledge determines the extent to which organizations can sustain a competitive advantage (Johannessen et al., 2001; Ng et al., 2012). While technology is seen as embodying the transfer of explicit knowledge, without tacit knowledge the background technology could never be fully adapted (Johannessen et al., 2001).

The importance of partnership characteristics for promoting the partners' propensity to share information is particularly relevant in the context of SMEs. In developing countries, managers of SMEs attempt to develop new practices, norms

and techniques that enable them to acquire knowledge, resources and capabilities needed for the successful transfer of new technologies from developed countries. Against this background, the research question of our study is as follows: 'How does knowledge sharing in partnership relationships affect the success of technology transfer?' A sample of Turkish SMEs was selected to address the research question in the light of partnerships between SMEs in developing countries and their partners from developed countries.

This study contributes to RBV of the firm by revealing the partnership characteristics that can reduce the tension between the need to protect knowledge as a source of competitive advantage and the need to share it in order to assist effective technology transfer. This study also adds new insights to the theory of KM by proposing a knowledge sharing model for effective technology transfer in partnerships. Furthermore, most KM research is limited to knowledge transfer at individual level (Çavuşgil et al., 2003) while this study explores knowledge sharing between donor companies from developed countries and recipient SMEs in developing countries.

The remainder of the paper is organized as follows. Section 2 provides the theoretical background of the study, section 3 outlines the hypotheses for the research model, section 4 presents the empirical results, section 5 offers a discussion of the results and their theoretical and managerial implications, and Section 6 summarises our conclusions.

Literature Review and Hypothesis Development

2.1 Technology Transfer in Alliances

Technology transfer is a process aimed at transferring technological hardware and specialized technical skills and knowledge from a creator to a recipient (Buratti and Penco, 2001; Perez and Sanchez, 2003). It enables the recipient to access the technological capabilities of the donor through established communication channels (Kotabe et al., 2002; Rogers et al., 2001). It is not only the cost of the transfer that is important but its effectiveness, which has created the need for collaboration. Thus, technology transfer is a complex process that requires clear goals from the onset to maximize the benefits for both parties (Aminullah and Adnan, 2012).

In the extant literature, the effectiveness of technology transfers is typically attributed to factors such as participants' experiences and expertise, characteristics of the technology, modes of technology transfer, absorptive capacity of the recipient of the technology, selection process, and degree of intellectual property rights protections (e.g. Kim, 1998; Grant et al., 2010). Studies on technology transfer tend to focus on dimensions such as level of technical understanding, growth potential of the technology, external pressures from competitors and markets, and the overlap of development activities (Burgelman et al., 2004). However, technology and knowledge are closely intertwined (e.g., Amessea and Cohendet, 2001; Levinson and Minoru, 1995) and a growing body of literature argues that the success of technology transfer in partnerships is closely related to knowledge sharing (e.g., Lin, 2003; Aminullah and Adnan, 2012). Hence, this study argues that the complex process of

technology transfer in partnerships cannot be fully understood without considering the key role played by knowledge sharing.

2.2 Knowledge Sharing in Technology Transfer

The terms "technology transfer" and "knowledge transfer" are often used interchangeably (Levinson and Minoru, 1995). Some scholars argue that technology is a form of knowledge (Garud and Nayar, 1994) because it consists of technical knowledge and participant skill as well as machines and mechanical equipment. This confluence of knowledge and technology has led some scholars to consider knowledge transfer and technology transfer as identical concepts. However, the more recent knowledge-based perspective on technology transfer recognises knowledge transfer as a discrete part of the replication process and proposes a model in which the effectiveness of technology transfer depends largely on the knowledge sharing processes that occur in partnerships (Amessea and Cohendet, 2001; Buratti and Penco, 2001; Rogers et al., 2001).

Knowledge sharing involves the transfer of knowledge from one (part of the) organization or individual to be replicated in another (part of the) organization or individual (Grant et al., 2010). Hence, the process of knowledge sharing as experienced by the donor is distinguished from the knowledge sharing as experienced by the recipient. For the latter, knowledge sharing is the systematic process of accessing, assimilating, retaining and organizing knowledge in order to replicate its successful application. For the donor, knowledge sharing refers to the willingness and ability to provide access to their own knowledge and assist the recipient in the process of assimilating and applying that knowledge.

One of the most important insights that the knowledge-based view offers to understanding the dynamics of technology transfer is recognizing that different types of knowledge have different characteristics (Nonaka and Takeuchi, 1995). For example, Robinson (1988) distinguished between an 'embodied element' and a 'disembodied element' of technical knowledge transfer. The former can be articulated and transferred between individuals and across space and time through language, formulae, blueprints, drawings manuals, and information technology at marginal costs. Such explicit knowledge is referred to as system-bound knowledge (Beijerse, 2000).

In contrast, the disembodied element - tacit knowledge - is seen as people-bound (Beijerse, 2000) because it consists of human skills and knowledge. It cannot be codified directly because it is context-specific, founded on individual experience, and deeply rooted in involvement, personal interaction, perceptions, and reflection. Tacit knowledge is observable only through application and acquired only through practice. Hence, the transfer of tacit knowledge tends to be difficult, slow, costly, and uncertain (Ng et al., 2012).

Recent studies have affirmed the importance of knowledge sharing for the effectiveness of technology transfer in partnerships (e.g. Borge and Bröring, 2017; Qui ey al., 2017). Technology transfer necessitates explicit knowledge sharing in various forms, e.g. through engineering handbooks, databases, reports, flow charts and various application-related documents. However, technology transfer may not be successful if the tacit knowledge, embedded in the donor organization, cannot be codified and shared with the recipient. Thus, tacit knowledge sharing is likely to

impact significantly on the effectiveness of technology transfer. Hence, we hypothesize:

H1: The effectiveness of technology transfer is positively related to a) tacit knowledge sharing, and b) explicit knowledge sharing.

2.3 Trust in Technology Alliances

Knowledge can be shared via conditioned by context interactions of varied intensity. The remarkable feature of knowledge as a resource is that its transfer from donor to recipient does not reduce the quantity of knowledge possessed by the donor (Leng, 2009). However, the value of knowledge may be diminished following the transaction because its scarcity is reduced. Hence, knowledge sharing in partnerships is challenging to say the least because alliance partners are likely to be concerned about opportunistic behaviour and unintended transfers of knowledge-based resources (Mowery et al., 1996). The challenge of knowledge sharing is even greater when inherently immobile tacit knowledge needs to be transferred and the partners need to be motivated to do so while concerned about opportunistic behaviours (Dyer and Nobeoka, 2000).

Trust between partners has been documented as one of the most important factors that influence the success of knowledge sharing in partnerships. Indeed, a trusting person is more willing to share tacit knowledge (Renzl, 2008) so individuals in collaborating organizations are more likely to communicate valuable knowledge following repetitive social interactions (Dyer and Nobeoke, 2000). Research on partnerships suggests that firms enter new collaborative relationships after considering the reputation of potential partners, advance existing relationships in

accordance with previous experience, and abstain from collaboration with previous partners if trust has declined (Estrada et al., 2016; Ivarsson and Alvstam, 2005; Stock and Tatikonda, 2000; Tiwana, 2008).

Hence, effective transfer of knowledge can only be achieved within a social framework that facilitates mutual trust between the collaborating parties (Stock and Tatikonda, 2000). Trust brings together the partners' mental models and approaches to information processing, and facilitates commitment, reciprocity, frequency, and intensity of transactions (Tiwana, 2008). Prior studies regard trust as a key factor in knowledge-sharing decisions and have illustrated the positive effects of trust on workplace attitudes, behaviours, and performance (e.g., Dahl and Pedersen, 2004; Jones and George, 1998; Mayer et al., 1995). Hence, we put forward the following hypothesis:

H2. Trust is positively related to a) tacit knowledge sharing and b) explicit knowledge sharing.

2.4 Sharing Channels

For knowledge sharing to take place, some communication mechanisms are needed. A sharing channel is any specific form of interaction between two or more social entities during which knowledge is transferred. The openness or richness of a sharing channel is determined by its directionality and capacity to convey information effectively (Oke and Idiagbon-Oke, 2010).

Sharing channels differ in their capacity to carry information (Thomas, 2013) and vary broadly from channels that involve personal contact, e.g. individual face-to-face communications, to more impersonal channels such as internet, intranet, email,

shared databases and various documents (Van de Ven and Ferry's, 1980). Different types of sharing channels can be used depending on the type of knowledge to be transferred, the organizational culture, the degree of dependence of the partner firms, the potential risk and the individuals involved.

The existing literature suggests that knowledge diffusion through informal, open, rich, two-way sharing channels most often occurs in the form of information trading (e.g., Parise and Casher, 2003). This type of informal knowledge exchange is a frequently observed phenomenon in product development and in the diffusion of technological innovation (Dahl and Pedersen, 2004). Inter-firm communication channels are seen as critical for integrating suppliers in product development (Lavie and Rosenkopf, 2006) while open sharing channels are argued to support interactivity, coordination, and resource sharing in alliances (Thomas, 2013). Knowledge sharing in partnerships is supported by open, rich, two-way sharing channels between the partners (Felin and Zenger, 2013) while bi-directional openness of sharing channels has a positive effect on performance and learning through promoting communication between the partners (Parise and Casher, 2003). Hence, we hypothesize that:

H3. Open sharing channels are positively related to a) tacit knowledge sharing and b) explicit knowledge sharing.

2.5 Technical Support

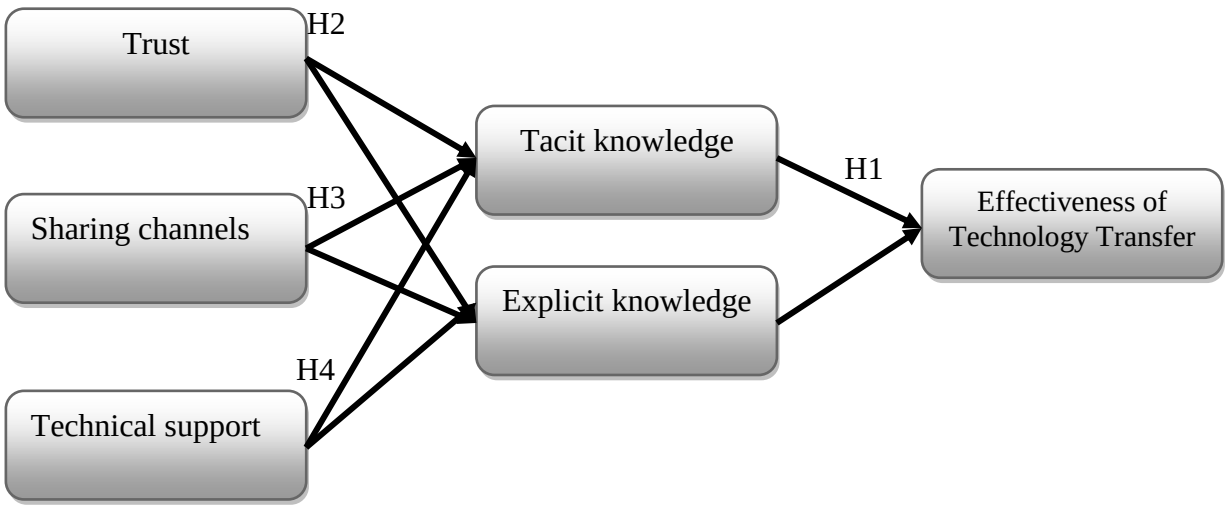
Successful technology transfer requires close cooperation and collaboration between the involved individuals as well as technical support (Gorschek et al., 2006), particularly in the case of process-related technology transfers that encompass not

only provision of machinery and equipment but also technical support with product planning, quality management, inspection, testing, advice on tooling, maintenance and operations (Ivarsson and Alvstam, 2005). Hence, technical support is a vital component that contributes greatly to the overall success of the technology transfer.

However, it is important to distinguish between technical support and knowledge sharing. Technical support involves the supplementary activities needed to support both tacit and explicit knowledge sharing, e.g., software tools and enterprise resource planning systems, as well as various forms of training on how to deploy the transferred knowledge in practice (Gorschek et al., 2006). Thus, technical support is a key feature of knowledge sharing processes. Employees working for different, even competing companies often provide technical advice and support to one another with the expectation that the favour will be reciprocated in the future (Dahl and Pedersen, 2004). Thus, we hypothesize that:

H4. Technical support is positively related to a) tacit knowledge sharing and b) explicit knowledge sharing.

Fig. 1: Proposed model



Research Design

3.1 Research Instrument and Sampling

The question items were identified on the basis of a comprehensive literature review and translated by using the parallel-translation method. The latter involves translation of the items to Turkish and subsequently re-translation to English to ensure consistency of meaning in both languages. The translators then worked jointly to reconcile the identified disparities and refine the questionnaire.

SMEs were selected from reports of the European Business Network, which documents technology transfer relationships between Turkish SMEs and Western firms. The European Business Network provides consultancy and training to over 50.000 SMEs, but only 146 of them were reported as having built technology transfer relationships.

The questionnaire was administrated to the sample of 146 SMEs, all of which were based in Istanbul, Turkey. The managers of these SMEs were initially contacted by telephone and the aim of the study was explained to them. Out of the 146 firms, 47 agreed to participate in the study. To avoid single-source bias, at least two respondents at middle management level and/or top management level participated in the survey from each firm. Out of the 47 firms that agreed to participate, 33 firms completed the survey in full. An overall adjusted response rate of 23 percent was achieved, with 105 completed questionnaires returned.

3.2 Measures

To measure the constructs, multi-item scales were adopted from prior studies. Each construct was measured using 7-point Likert scales ranging from "strongly disagree" (1) to "strongly agree" (7) To measure tacit and explicit knowledge sharing, question items were adopted and modified from Lee (2001). Four questions for explicit knowledge sharing and three for tacit knowledge sharing were used. To measure trust between the partners in the technology transfer process, four questions were adopted from Norman (2002). Five questions were used regarding openness of sharing channels and knowledge flows between partners. These items were adapted from Norman (2002) but originate from Calantone et al. (1993). To measure technical support, five items were adapted from Kotabe et al. (2002), including formality, and direction and frequency of support activities between technical staff and partners.

To measure the effectiveness of technology transfer, question items were modified from Lin and Berg's (2001) scale. Consistent with their study, five questions were used regarding technical effectiveness, effectiveness compared to other projects, competitors, expectations, and overall satisfaction with the transfer process.

3.3. Measure Validity and Results

One-model confirmatory factor analysis (CFA) was employed to test convergent by using AMOS 20.0. The comparative fit index (CFI), root mean square error of approximation (RMSEA), incremental fit index (IFI) and Tucker-Lewis Index (TLI) are the major indicators of model fit. The threshold value for CFI, IFI

and TLI are greater than or equal .85, which represents an acceptable fit. In addition, values of RMSEA less than or equal to .1 are considered to be a relatively good fit for a model. These indicators and their corresponding threshold values are presented in Table 1, which illustrates that the resulting measurement model fits the data satisfactorily (*CFI* = .88; $\chi^2_{(214)}$ = 448.426; *IFI* = .88; *TLI* = .86; χ^2/d.f. = 2.09; *RMSEA* = .09). In addition, all items loaded significantly on their respective constructs (with the lowest *t*-value being 2.50), providing support for convergent validity.

Table 1: Measurement models and confirmatory factor analysis

Construct	Parameter[a]	Standardized Coefficient	*t*-Value[b]
OSC	λ_{OSC1}	.72	Scaling
	λ_{OSC2}	.61	6.23
	λ_{OSC3}	.76	7.35
TS	λ_{TS1}	.83	Scaling
	λ_{TS2}	.87	10.97
	λ_{TS3}	.78	9.26
	λ_{TS4}	.65	7.18
T	λ_{T1}	.88	Scaling
	λ_{T2}	.92	13,65
	λ_{T3}	.77	9.61
	λ_{T4}	.84	10.95
EKS	λ_{EKS1}	.92	Scaling
	λ_{EKS2}	.93	15.12
	λ_{EKS3}	.73	9.39
	λ_{EKS4}	.67	8.15
TKS	λ_{TKS1}	.87	Scaling
	λ_{TKS2}	.81	10.64

	λ_{TKS3}	.92	12.51
TT	λ_{TT1}	.77	Scaling
	λ_{TT2}	.74	7.78
	λ_{TT3}	.66	6.78
	λ_{TT4}	.84	8.88
	λ_{TT5}	.84	8.85

a λ parameters indicate paths from measurement items to first-order constructs
b Scaling denotes λ value of indicator set to 1 to enable latent factor identification.

Note$_{1.}$ $\chi^2_{(214)}$ = 448.426, CFI = .88, IFI = .88, TLI = .86, RMSEA = .09.

Notes$_{2}$. OSC = Open Sharing Channels, TS = Technical Support, T = Trust, EKS = Explicit Knowledge Sharing, TKS = Tacit Knowledge Sharing, TT = Technology Transfer

All reliability estimates - Cronbach's Alpha (α), average variance extracted (*AVE*), and composite reliabilities (*CR*) - are well-beyond the threshold levels (Nunnally, 1978; Fornell and Larcker, 1981). Table 2 shows the correlation among all six variables, providing further evidence of discriminant validity.

To fully satisfy the requirements for discriminant validity, AVE for each construct should be greater than the squared correlation between the constructs (Fornell and Larcker, 1981). Such results suggest that the items share more common variance with their respective constructs than any variance the construct shares with other constructs. In the model, none of the inter-correlations of the constructs exceed the square root of the AVE of the constructs (see Table 2).

Table 2. Correlations and Descriptive Statistics

No	Mean	Standard Deviation	Variables	1	2	3	4	5	6
1	5.32	1.16	OSC	**.82**					
2	5.33	1.13	TS	.79**	**.84**				
3	5.76	1.06	T	.52**	.44**	**.89**			
4	5.15	1.40	EKS	.64**	.72**	.39**	**.88**		

5	4.98	1.48	TKS	.65**	.63**	.49**	.70**	**.92**	
6	5.47	1.37	TT	.55**	.52**	.51**	.38**	.35**	**.81**
			CR	.86	.91	.94	.93	.94	.91
			AVE	.67	.71	.79	.78	.84	.67
			α	.75	.86	.91	.91	.90	.88

* $p < .05$, ** $p < .01$.

Note₁. Diagonals show the square root of AVEs.

Note₂. OSC = Open Sharing Channels, TS = Technical Support, T = Trust, EKS = Explicit Knowledge Sharing, TKS = Tacit Knowledge Sharing, TT = Technology Transfer, CR = Composite Reliability, AVE = Average Variance Extracted, α = Cronbach's Alpha

3.4. Hypotheses Testing

Table 3 shows the results of the hypotheses testing. Regarding antecedents of knowledge sharing, trust is found to be positively associated only with tacit knowledge sharing (β = .34, $p < .01$), partially supporting H2. Technical support is positively related to both explicit knowledge sharing (β = .60, $p < .01$) and tacit knowledge sharing (β = .30, $p < .05$), fully supporting H4.

To our surprise, the findings provide no empirical evidence in support of the relationship between open sharing channels and knowledge sharing, thus rejecting H3.

Regarding knowledge sharing in technology transfer relationships, the findings show that only explicit knowledge sharing positively affects the effectiveness of technology transfer (β = .27, $p < .05$), partially supporting H1.

Table 3: The Results

Paths			Betas (β)	Sub-Hypotheses	Sub-Results	Hypotheses	Results
EKS	→	TT	.27*	H1a	Supported	H1	Partially Supported
TKS	→	TT	.17	H1b	Not Supported		
T	→	EKS	.08	H2a	Not Supported	H2	Partially Supported
T	→	TKS	.21*	H2b	Supported		

OSC	→	EKS	.10	H3a	Not Supported	H3	Not Supported
OSC	→	TKS	.29	H3b	Not Supported		
TS	→	EKS	.60**	H4a	Supported	H4	Fully Supported
TS	→	TKS	.30*	H4b	Supported		

Note. OSC = Open Sharing Channels, TS = Technical Support, T = Trust, EKS = Explicit Knowledge Sharing, TKS = Tacit Knowledge Sharing, TT = Technology Transfer
*$p < .05$, ** $p < .01$

The PLS structural model is mainly evaluated by the coefficient of determination (R^2) of the endogenous latent variable (Chin, 1998) and Goodness-of-Fit index (*GoF*) (Tenenhaus et al., 2005). R^2 is normed between 0 and 1, and used to describe how well a regression line fits a set of data (Chin, 1998). According to Chin (1998), threshold R^2 values of .26, .13, and .02 for endogenous latent variables are considered to be large, medium, and small respectively. GoF is employed to judge the overall fit of the model globally through seeking harmony between the performance of the measurement and the structural model. In accordance with the categorization of R^2 effect sizes, the effect sizes for our constructs are large for the value of explicit knowledge sharing (R^2 = .53tacit knowledge sharing (R^2 = .49), and technology transfer (R^2 = .16). Following the categorization by Cohen (1988) and using .5 as a cut-off value for communality (Fornell and Larcker, 1981), the GoF is .54 for our model which indicates a good fit (Table 4).

Table 4: Structural Model

Fit Measures	Endogenous Constructs	Results
R^2	Explicit Knowledge Sharing	.53
	Tacit Knowledge Sharing	.49
	Technology Transfer	.16
GoF		.54

Note. GoF = √ Average Communality x Average R^2

3.5. The Mediating Role of Knowledge Sharing

To test the mediating effect of knowledge sharing as a characteristic of technology transfer in partnerships, we employed the Baron and Kenny (1986) procedure. We performed three different SEM models, presented in Table 5. Model A, which includes all characteristics of partnership variables and technology transfer, demonstrates that trust (β = .31, p < .01) is positively related to technology transfer, and R^2_{TT} = .41.

Model B, covering the character and knowledge sharing-related variables, illustrates that technical support (β = .60, p < .01) is positively associated with explicit knowledge sharing while open sharing channels (β = .29, p < .1), technical support (β = .31, p < .05) and trust (β = .21, p < .1) are positively associated with tacit knowledge sharing, and (R^2_{EKS} = .53) and (R^2_{TKS} = .48).

After controlling for character-related variables in model C, we find that explicit knowledge sharing (M) (β = -.01, p > .1) and tacit knowledge sharing (β = -.14, p < .1) are not statistically related to technology transfer. In addition, knowledge sharing reduces the effects of character-related variables on technology transfer, and the inclusion of knowledge sharing variables in the model slightly decreased the R^2 of technology transfer (R^2_{TT} = .40). These results show that knowledge sharing mediates the relationship between the character-related variables and technology transfer.

Table 5: The Mediating Role of Knowledge Sharing

Paths			Model A	Model B	Model C
OSC	→	TT	.22		.25

TS	→	TT	.22		.26
T	→	TT	.31***		.35***
OSC	→	EKS		.10	.10
TS	→	EKS		.60***	.60***
T	→	EKS		.08	.08
OSC	→	TKS		.29*	.29*
TS	→	TKS		.30**	.29*
T	→	TKS		.21*	.22**
EKS	→	TT			-.01
TKS	→	TT			-.14

Note. OSC = Open Sharing Channels, TS = Technical Support, T = Trust, EKS = Explicit Knowledge Sharing, TKS = Tacit Knowledge Sharing, TT = Technology Transfer

*$p < .1$, **$p < .05$, *** $p < .01$

Results and Discussion

Globalization has been forcing SMEs in newly industrialized countries to play in the same league as companies from developed countries. Through securing technology and know-how in technology partnerships with companies from developed countries, many SMEs from newly industrialized countries have started to compete successfully at the international arena despite limited knowledge infrastructure and R&D resources. This study is one of few that examine technology transfer from a knowledge-based perspective and contributes to KM by offering a framework for understanding how partnership characteristics - trust, technical support and open sharing channels - promote knowledge-sharing activities thus contributing to the effective transfer of technology in partnerships. Furthermore, the proposed knowledge-sharing model incorporates both tacit and explicit knowledge and, while most extant studies focus on large enterprises, it examines partnerships between recipient SMEs in newly industrialized countries and donor companies in developed countries.

Specifically, this study makes four contributions to the KM literature. First, it explores the role of partnership characteristic as antecedents of knowledge-sharing activities within partnerships. The findings demonstrate that trust is positively associated with tacit knowledge sharing in partnerships, i.e. partners are less worried about opportunistic behaviours and more willing to share valuable tacit knowledge when they trust each other. Tacit knowledge is uncodified, so it is not a readily transmittable formal, systematic language and it is not embodied in computer programs, patents, or diagrams. Therefore, effective tacit knowledge sharing requires partners to engage in sharing activities eagerly and willingly.

The findings also highlight the important role of technical support as a key antecedent to both tacit and explicit knowledge sharing in partnerships. This finding implies that technical advice, training programs and system support through formal, systematic means and language are more relevant to explicit knowledge sharing than trust or informal sharing channels. This finding also demonstrates that formal transfer mechanisms deployed in technical support processes, e.g. information technologies and formal training programs, may promote interactions among the employees of partner firms, thus stimulating both tacit and explicit knowledge sharing. Technical support processes, planned in a way that provides opportunities for the involved individuals to work together, encourages communication and tacit knowledge sharing. Hence the findings emphasise the importance of human relationships for successful tacit knowledge sharing.

Surprisingly, we could not find any direct statistical correlation between trust and explicit knowledge sharing. This could be explained through the intrinsic characteristics of explicit knowledge. The latter is a system-bound type of

knowledge, typically easy to articulate and share systematically. Moreover, contrary to our expectations, the results did not suggest any association between open-sharing channels and knowledge-sharing activities, independent of the types of knowledge to be shared. This conflicting result may be attributed to the inability of the firms in our sample to establish open, rich, informal, communication channels in their partnerships. Although our sample consisted of SMEs, which had undertook partnership training and built international transfer relationships, it is likely that they lacked experience in international collaborations, so they were unable to establish and exploit sharing channels.

The second contribution this study makes to KM is the examination of the effect of knowledge sharing on the effectiveness of technology transfer in the context of partnerships. The results confirm a statistically significant positive relationship between explicit knowledge sharing and the effectiveness of technology transfer. In other words, explicit transfer and communication of technical information and know-how in the form of computer programs, patents, blueprints, and diagrams between units, groups, and hierarchical levels play a critical role in accessing, replicating, and implementing the technologies under transfer. This finding implies that managers of companies involved in technology transfer should work together to ensure that all relevant documentation and information is prepared in appropriate formats and made available to the working teams.

Surprisingly, no empirical support was found for a direct relationship between tacit knowledge sharing and technology transfer. This finding, paired with the confirmed strong influence of explicit knowledge sharing on the effectiveness of technology transfer, contradicts previous studies (e.g. Cavusgil et al., 2003; Nonaka,

2008; Riege, 2005; Smith, 2001) which have asserted that explicit knowledge-sharing systems and activities do not add value. This inconsistency could be attributed to the typically flat organizational structure of SMEs, in which vital knowledge is often stored in the minds of a few key employees who act as gatekeepers of tacit knowledge transfer. This implies that the inclusion of such key employees in the teams working on the technology transfer is vital to the success of tacit knowledge sharing.

Moreover, SMEs often lack formalized systems and methods for knowledge storing and processing. Hence, it could be argued that SMEs involved in technology transfer partnerships might benefit more from access to well-organized systems for transfer and storage of explicit knowledge than from tacit knowledge sharing because of their intrinsic deficiency of organizational capabilities. This interpretation appears even stronger when applied to SMEs in developing countries.

Another explanation could be that tacit knowledge sharing may influence technology transfer via explicit knowledge sharing due to the significant covariance between explicit and tacit knowledge sharing. This explanation is in agreement with the extant literature, which considers tacit and explicit knowledge as complementing each other. In other words, the knowledge context created by the dynamic interaction of tacit and explicit knowledge is likely to influence any knowledge sharing.

The third contribution of this study adds insights about the significant role of partnership characteristics in technology transfer. While the effectiveness of technology transfer increases with the intensity of knowledge sharing, partnership variables, e.g. trust, also affect the success of technology transfer. Well-structured partnerships are more likely to achieve effective knowledge sharing and successful

technology transfer. For instance, technical support processes provide context for the involved individuals to work together, interact, and socialize thus promoting tacit knowledge sharing. The trust that evolves in this context contributes to partnership success by supporting acceptance of vulnerability based on positive expectations of the partners' intentions or behaviours. Hence, the partnership context, in which individual and functional expertise is structured, coordinated, and communicated, encourages the partners to share tacit knowledge. Thus, our findings contribute to KM by promoting a human-oriented partnership design, based on trust and technical support.

Last but not least, our findings demonstrate that the relationship between partnership characteristics and technology transfer is mediated by knowledge sharing. This result highlights the benefits that firms can attain from carefully crafted and executed technology transfer partnerships. Knowledge sharing is a mechanism that can enable SMEs from newly industrialized countries to acquire the knowledge, resources, and capabilities necessary for the utilisation of up-to-date technologies and compete successfully at international level despite their limited knowledge infrastructure and R&D resources.

The results of this paper also have implications for RBV, which asserts that VRIO resources and capabilities provide a sustainable competitive advantage for the firm. However, it overlooks the tension between the need to share knowledge in partnerships and the need to keep it in-house to loss of competitive advantage. This study finds that mutual trust creates collaborative environment thus supporting knowledge-sharing by reducing the anxieties related to potential opportunistic behaviour.

Technical support contributes to building trust in partnerships hence encouraging the partners to share knowledge eagerly and willingly. These findings contribute to RBV by highlighting the positive effects of trust and technical support on the intensity of knowledge sharing in technology partnerships. Further, this research demonstrates that increased intensity of knowledge sharing in a well-structured relationship, characterized by trust and adequate technical support, is positively associated with effective transfer of up-to-date technology and contributes to the success of technology partnerships.

This study finds that knowledge-sharing activities and the antecedents of knowledge sharing form the very fundament of technology transfer while human relationships largely determine the success of tacit knowledge sharing. Specifically, the findings demonstrate that mutual trust and technical support are key variables impacting on knowledge-sharing activities between partners while explicit knowledge sharing affects the effectiveness of technology transfer in partnerships.

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